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BRIEFS

COAL CONVERSION PLANS CURTAILED--Bonn--The RFG has revised downward its alternative energies program for producing gas and gasoline from coal, it was announced 21 October in Bonn. For technical and financial reasons, indicated an informed source, probably only three or four of the 11 large-scale gasification plants originally envisioned will be built. As for the three coal liquefaction plants and the lignite liquefaction plant, which are slated to be built between now and 1992, no decision was made, but there too it is probable that the program will be curtailed. According to an official statement issued after the federal cabinet meeting at which the program was reevaluated, seven gasification projects representing a total investment of DM 4.7 billion ($2 billion) are still on the agenda. According to the statement, the projects ultimately approved will be eligible for federal government financing of up to 40 percent of the total amount of the entire investment. For that purpose, it was decided by the cabinet, a total of DM 1 billion of credit is to be set aside for 1982 through 1985. As concerns liquefaction, the statement indicates that DM 100 million in research credits have been written into the 1982 budget to provide financial support for the pursuit of studies on the four projects proposed by the West German industry. At the Ministry of the Economy it is indicated that the three or four large-scale gasification plants having the greatest chance of being built are those planned by the Ruhrkohle-Ruhrchemie, Kloeckner, and Rheinbraun firms and the West German subsidiary of Shell. The projects planned by the first three of these firms represent a projected total annual production of 3.3 billion cubic meters of synthesis gas by about 1986, which would satisfy about 5 percent of the annual gas consumption of the FRG. [Text] [Paris AFP SCIENCES in French 22 Oct 81 p 36] 9828

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INDUSTRIAL TECHNOLOGY

LASERS GAIN IMPORTANCE IN INDUSTRIAL APPLICATIONS

Paris L'USINE NOUVELLE in French 19 Nov 81 pp 118-124

[Article by Patrick Piernaz: "The Laser Revolutionizes Manufacturing"]

[Text] Precision, quality, high cutting speed, and reliability are enabling the laser to make a virtual forced entry into manufacturing shops. Whether used for cutting steel, ceramic, fabrics, paper, plastics, or whatever, its applications seem endless, and the market opportunities are enormous.

A slight hissing, a workpiece being pulled in a rotating motion. That is all. In 15 seconds a commutator for an automobile starter was "machined by light." The absolutely invisible beam from a 1,200-W carbon dioxide laser shone on the workpiece and tracked across its surface like a stylus moving across a record--a "record" composed of sheets of copper separated by Bakelite, which had to be scraped to a certain depth. Delicate work. In conventional milling, up to now, it was necessary to take care to avoid touching the copper sheets. The laser is not hampered by these limitations. It illuminated everything, but only the Bakelite was vaporized. The engineers simply utilized the property that copper reflects like a mirror the radiation from this type of laser.

This equipment, the only equipment of its kind in the world, has been in operation for 6 weeks amidst other machines in the shops of the Paris-Rhone company in Lyon. The operation is repeated 250 times an hour, 16 hours a day. The tempo is intense. This application brilliantly shows that the laser in the industrial sector is not confined to the laboratory. Its reliability and its efficiency make it a superb tool. At Paris-Rhone the laser machine works at the speed of six conventional milling machines or four of the new advanced machines. At equal capacity the investment proves to be 20 percent less expensive, and the cost of the machining operation is 20 percent lower. "But primarily," insists Michel Geay, the person in charge of the new developments, "the use of the laser has put an end to the mechanical contact between the tool and the workpiece. There is no longer a risk of jarring the sheets, which could cause their detachment. The result: Our starters have better quality and are made with increased reliability."

Subcontractors Are Getting the Equipment Sooner

This is not an isolated example. The laser is in the process of revolutionizing manufacturing. Enteprises which have had the courage to acquire laser equipment are already scoring points. At SNIAS [National Industrial Aerospace Company] of

Marignane, part of the worldwide success of the Ecureuil and Dauphin helicopters is attributable to their glass fiber reinforced rotor hubs, the elements of which are cut with precision using the laser. In this application, the laser has replaced manual cutting on the "cutter," resulting in a sixfold reduction of working time and a radical elimination of defects. The laser also has supplanted a manual operation at Delta Voiles [Delta Sails] in Montpellier, where the chairman, Michel Mante, wanted "to put an end to the backbreaking task of the cutter, who worked on his knees on the floor." As an extra benefit, the execution time was reduced by a factor of four and the accuracy of the cutting has given the owner of this small to medium-size industrial enterprise a head start on the American sailmakers, who still use traditional methods.

And there is no shortage of other examples. To name a few, at Liebherr, in Colmar, power shovel cabs are cut by laser; at Acrilux, in Ivry-sur-Seine, electric signs are made; the Papeteries de Malaucene [Malaucene Paper Mills], near Carpentras, make tens of thousands of holes per second in cigarette paper. And the future applications are completely astonishing, too. At Renault there is a laser which will soon be stripping insulation from electric wires; at Eram, for the first time in the world, a battery of machines will cut out the leather parts for shoes, at one stroke eliminating the very costly cutting tools while achieving appreciable raw material savings.

The industrial uses of the laser seem endless. Furthermore, they are not limited to cutting, but also include welding, thermal treatment of surfaces, and marking of parts. And, as with any new technique, according to a phenomenon already observed with machining by numerical control or with electrical discharge machining by wire, the subcontractors have been the first to sense the opportunity and are acquiring laser equipment sooner than the large companies.

That is true for Getelec, among others, a small to medium-size industrial enterprise in Clamart with 25 employees, who cut and bore holes in ceramic hybrid circuits. "The big companies at first subcontracted some parts out to us to find out about the feasibility of the operation before buying the equipment for themselves," explains Gerard Dusailly, manager of Getelec. "Now they still continue to pass some orders along to us, since we offer quick lead times, on the order of 8 days for production runs of 10 to 100 pieces. Our laser operates 8 to 16 hours a day."

But when the laser is mentioned, the conversation usually revolves mainly around materials such as Bakelite, glass fiber, leather, plastics, ceramics, and the like. And what about metal? Well, the applications were relatively scarce until just recently, but since the beginning of the year things have changes, since one rainy day in January when a German truck pulled up at the gates of the Nollet Company in Lys-lez-Lannoy, near Roubaix. It came to deliver the first laser punch/nibbling machine to be installed in a French factory.

"I felt that there was a market in the subcontracting field for cutting sheet metals with the laser," recalls Philippe Nollet, the chairman. "But it took us several months to find it." His market includes small runs of sheet metal items, which would be too small to allow amortization of a cutting tool; machining of hard metals and annealed parts, which the laser can machine without reworking and without subsequent truing; delicate and intricate parts incapable of being produced on the press; etc. His market also includes any parts needed in a hurry. When the program is already available, a production run can be turned out in 48 hours, whereas a

special tool would require a 2-month wait. "This means that large runs of items are not off limits to the laser," explains Philippe Nollet. "As proff: We have already filled a rush order for circlips for an automaker."

But Philippe Nollet, who now has his order book filled 3 months in advance, will not remain in all alone in this favorable position for long. The firm Le Materiel de Voirie [Roadway Equipment] in La Charite-sur-Loire installed a machine of the same type to use partly for subcontracting work, followed in July by Stemp in Roissy-en-Brie, one of the most modern sheet metal plants in France, which acquired a cutting machine equipped with a 1,200-W laser. "We are the first plant in France to have a numerical control punch, a machine considered commonplace nowadays. We wanted to use the laser to regain the lead over our competitors and rapidly apply our know-how to this market," explains Bernard Radier, president of Stemp. Almost simultaneously another subcontractor, Socomec in La Souterraine north of Limoges, installed a laser-equipped numerical control punch in its shop "to get away from our traditional market of large-run parts and diversify in the direction of a different clientele," says Gerard Viniane, technical director.

No doubt the introduction of powerful lasers into the plants of subcontractors will revolutionize the market, because their first job is to acquaint the design departments with what the laser can do, as Philippe Nollet explains. "Engineers from all corners of the globe are seen trooping through our facilities, having come to investigate the possibilities of applying the laser to their problems in cutting out chain links, farm equipment joint supports, car seats." This groudwork begins with tests, orders for prototypes, and preproduction runs. And when these enterprises become convinced of the feasibility of the process, they will order the equipment for themselves. Only at that time, toward the middle of the 1980's, will the market really be in a position to take off.

This is not to imply that it has not already developed quite well on its own. "The sales of lasers for cutting metals have tripled over the last 2 years, and the rate of growth will not be less than 20 percent per year over the next 5 years," confirms Scott Nix, manager of Coherent BmbH in German.

Presently, the market for the laser is dominated by the Americans, with two giants in the lead: Spectra-Physics (Fr 840 million in revenues), which in 1979 bought the laser division of GTE-Sylvania, and Coherent (Fr 390 million in revenues), which in 1978 acquired Laser Inc. But these companies do not derive all of their revenues from industrial lasers. And they have to compete against some enterprises of more modest size but well entrenched in their special niches, such as Photon Sources, Avco, and Control Laser, which last year acquired the laser division of the British firm Boc Limited. As a matter of fact, the industrial market, according to the trade journal LASER FOCUS, increased to FR 390 million for 1980, and this year exceeded FR 447 million. Half of this market is in carbon dioxide lasers, the rest being split up among the various types of crystal lasers, particularly the YAG laser.

Principal Characteristics for Industrial Applications

Type of Laser	Active Material	Wave-length (H)	Mode of Operation	Method of Excitation	Energy or Power	Applications
Pulsed YAG	Yttrium aluminum garnet doped with neodymium	1.06	Pulsed	Optical	A few joules	Adjustment of resistance, machining thick or thin films, spot welding, piercing small holes
Continuous YAG	"	1.06	Continuous	Optical	Up to 900 W (laboratory)	Welding, piercing
Glass doped with neodymium	Glass doped with neogymium	1.06	Pulsed	Optical	Up to 500 W	Piercing
Ruby	Alumina doped with chromium	0.69	Pulsed	Optical	Up to 500 J (Laboratory)	Piercing of considerable thicknesses
Carbon dioxide	CO_2 in presence of nitrogen and helium	10.6	Continuous	Electric discharge	Up to 2 kW (industrial) 20 kW (semi-industrial)	All treatments of materials, welding, cutting, piercing, thermal treatments

Source: Institut de Soudure [Welding Institute].

Curiously, the Japanese are absent from this market. But for how long? Mitsubishi, Hitachi, Toshiba, and Matsushita are all known to be working overtime to close this gap. This would only be to succeed in building the famous "factory without people" desired by the Japanese Ministry of Industry. This would be a plant where one 20-kW laser source would serve to distribute through the shop a beam off which the machines would be "branched." Meanwhile, the European manufacturers are not sitting still; there is the case of J. K. Lasers in England and Laser Optronic and Carl Baasel in Germany, not to forget Messer-Griesheim specializing in oxygen cutting, which succeeded in selling 50 500-W laser machines, two of them in France. French laser manufacturers are no longer entirely absent from the market. Specifically, a small to medium-size industrial enterprise in Bordeaux, Lectra Systems, had already sold on the world market 200 machines for cutting cardboard patterns used in the

ready-to-war garment industry. But primarily France can claim to have on its soil the first European manufacturer, Compagnie Industrielle des Lasers (CILAS [Laser Industrial Company]), a subsidiary of CGE [General Electric Company], which was one of the first to enter the market, by selling--starting in 1975--a Moulinex laser used in the manufacture of vegetable mills. Since then, it has followed a "stop and go" policy, which has had the result that up to now it has not served very many industrial applications nor has it offered a complete line of machines. "We arrived on this market very early, perhaps even too early," explains Roland Roux, head of the private-sector commercial division of CILAS. "And we wore ourselves out selling the installations one by one on a market which was not ready. To stay afloat during that period, we successfully branched out into two bread-and-butter sectors: The medical laser and grain size measurement." With the latter application, CILAS managed a world breakthrough: It sold 10 instruments in Japan, 15 in the FRG, and several tens in the othe European countries. The sales of these instruments are showing a growth of 25 to 30 percent per year.

But the enthusiasm which presently reigns in cutting equipment has prompted CILAS to prepare for its return to this stronghold, particularly given that this company, which does 75 percent of its business (Fr 100 million) in military applications, would like to cut back the military/civil ratio to about 50/50. Furthermore, it has always maintained a presence on the market, selling among others the two 10-W lasers to Delta Voiles, a 3-kW laser to the AEC [Atomic Energy Commission] for studying the use of the laser in a contamination zone, and especially a 1-kW laser to an Italian subcontractor, Cavis, which cuts premolded moquettes for Fiat. The latter installation has been run for 5,500 hours. Furthermore, it was CILAS which was chosen by SNIAS to furnish a new machine for cutting glass and carbon fibers, which will be installed in Marignane at the end of the year. To obtain a better hold on the market, CILAS will round out its product line. It offers two 20- and 50-W models, and covers the range from 1 to 3 kW thanks to its agreements with its former Belgian affiliate CBL [Belgian Laser Company]. Two new lasers are under study, a medium power model (500 W) and a high range model (5 kW).

For these developments, the French company would be able to take advantage of part of the development assistance credits available through the Ministry of Industry. Only part, since the public funding could also go to aid the rising star of the Fench laser, Claude Benedite, a physicist who left the teaching profession to set up his own company, the Claude Benedite Laser Techniques firm, in the Limoges area. A truly amazing man, this Claude Benedite. The laser machining equipment at Paris-Rhone is his; the cutting of leather at Eram is also his doing, as well as the Stemp laser, the Socomec laser, the stripping of electric wires at Renault, and on and on. A man who started with nothing 2 years ago, who knew how to discover new markets, propose solutions, and deliver turnkey equipment.

The development of his business has also been quite amazing. "All our predictions have been surpassed; for 1981 our business will be about Fr 13 million, and we had only been aiming for Fr 2.5 million," explains Claude Benedite, who has not had difficulty finding private funding to swell his capital from FR 330,000 to FR 2.5 million. His premises are going to be enlarged by 800 m^2.

First Affected: The New Projects Department

For the time being, Claude Benedite installs and adapts lasers from an American source (Photon Sources) and builds turnkey machines. However, he wants to produce lasers completely "made in France" and wants to obtain on the French market such

items as optical components (mirrors and lenses), tubes, current regulators, vacuum pump systems, etc. This already very advanced project will soon lead to the creation of a new company, the Compagnie Francaise des Lasers Industriels [French Industrial Laser Company].

There is in fact an opportunity to be seized by the French laser manufacturers to the extent that the market has not yet taken off. The Americans, if they are present in France, have not really "gone all out" on our market. Perhaps they are still too preoccupied up with their domestic market, which represents 70 to 80 percent of sales. But this situation will change. Lawrence Osterink, manager of the industrial laser division of Spectra-Physics, estimates in an interview in LASER FOCUS that "the American Market ought to decline, while the Japanese market should expand by a factor of 10 over the next few years. As for Europe, sales could build even faster, at a rate of 50 percent per year until it catches up to the American level."

In any case, the first French users will shape up as something of pioneers, since if the laser revolutionizes machining, it will also cause considerable unsettling of work habits. Whether buying the machine, installing it, putting it in production, or maintaining it, employees of the user companies are confronted with new problems imposed by a technological change. First to be affected by this change is the new projects department, because primarily it is necessary not to labor under the misconception that the laser is an ordinary instrument. "A laser is first of all an optical system" insists Claude Benedite. "It must be protected from vibrations, dust, and the temperature variations which cause expansion of the lens mounts." It is best to deal with all these problems at the same time the layout is being worked out.

Perhaps not everyone will have to take the same measures as Philippe Nollet, who had a special 625 m^2 area constructed with electric heating through the floor, the cost for which came to FR 1 million, yet that is certainly a good way of maintaining and protecting the adjustment of his equipment. Paris-Rhone did not take things lightly either: "We intended to install the laser in the production ship. It was necessary to eliminate vibrations at any cost," explains Michel Geay. "We therefore recorded vibration profiles at floor level and constructed a concrete slab mounted on Silentbloc to isolate the resonator. Moreover, it is separated from the work area by a wall. And the temperature in the shop is maintained through the night." At Socomec, also, the machine was placed on an isolated concrete slab a meter thick. "But, in spite of everything, the machine vibrated; it was necessary to brace it and tighten it down," recalls Gerard Viniane.

On general principles a business executive should think about informing his personnel to ensure the success of the operation. "It is very important for him to get his colleagues involved in the introduction of this new means of production," agrees Bernard Radier, who conducted numerous demonstrations intended to reach all members of the company. Michel Geay asked the maker to show a film; he also supplied information regularly to the joint production committee and the health and safety committee. Meanwhile, the safety engineer asked the factory inspection team to come see the machine. "And then we spent 10 days to inform the people in small groups: Engineers, foremen, controllers, employees, anyone who wanted to could come." After the installation, Michel Geay made it a point to act on the two main comments of the personnel: The noise, which necessitated isolating the work platform, and the lack of comfort of the safety glasses (he is going to have some specially fitted glasses made).

When all these aspects have been analyzed, there is nothing left to do but start up the machine. Hold on, no such luck! Months will go by before this machine produces at full capacity. "It took us nearly a year to finish our apprenticeship, master the adjustment parameters, and invest in client studies while perfecting part programs," Gerard Dusailly of Getelec is careful to point out. This situation is common among all subcontractors, who are only able to adjust their machine for a single type of part. In another case, the orders may not come right away, and it is necessary to proceed with some tests. "In the beginning, the machine only worked efficiently about a fourth of the time," declares Philippe Nollet. "The rest turned out to be spent in equal parts on adjustments, tests, and maintenance."

Furthermore, adjustment of the laser is not the only source of problems. By itself, it is nothing but a ray of light. It is necessary to add to it a system for displacement along two or three axes, which will provide the cutting motion. And everything is actuOted by a numerical control system. Manufacturing with the laser, therefore, implies first programming the design of the part on a numerical control system. "In that, it is not necessary to restrict ourselves to simple programs," advises Philippe Nollet, "since the laser's strong suit is really the complicated parts. Thus, for our first applications the time for programming could be as much as 4 or 5 hours, while themachine work per se did not take more than 40 to 50 minutes." Philippe Nollet, who was not big on programming, finally decided to acquire a very powerful programming assistance system, which made it possible to cut the time for punched tape preparation by a factor of four. Stemp, which was already familiar with the programming of numerically controlled punches, nevertheless acquired a sophisticated numerical control system in order to deal with all these problems properly. This does not prevent Pierre Fournier, the technician in charge, from often "having to stay late in the evening in front of his machine with the manual written in English," and he considers it necessary to have a good math background to solve all the elaborate cutting situations.

Even the cutting of sails poses difficult geometry problems, enough to justify the acquisition of a powerful (64K) General Automation computer. "Because our strength with the laser was in cutting precise, and accordingly complicated, shapes, which are described by equations of the third or fourth degree," explains Bernard Mallaret, engineer at Delta Voiles. That all tends to explain why the people in charge of the use of these machines are very often on the senior technician level and often take an 8- to 15-day course at the laser factory.

This is particularly true as regards the maintenance problems, which crop up after a few weeks of use. Indeed, though the industrial lasers are considered reliable, their maintenance is nonetheless very exacting. "Not too much even then," adds Claude Benedite. "It is not necessary to be an expert in lasers to operate one and maintain it." These continual maintenance operations can easily be handled by a technician at the user company: Regular cleaning of the optics (lenses and mirrors), replacement of the dry filters in the gas circuits (every 3 months), and changing the oil on the vacuum pump (every 3 months). The major repairs are reserved for the maker. "This is not to say that one should stand idle in a case of a sudden breakdown," explains Michel Geay. "It is necessary to know how to identify the prblem and try to localize it with help, over the telephone, from the maker. In 90 percent of the cases it is possible to do some good and save precious time that the machine would otherwise be out of commission."

It is thus a very good idea to thave replacement parts on hand at the user's plant. For example, SNIAS of Marignane considers it appropriate to stock all key parts: Mirrors, lenses, circuit boards, etc., and even three complete replacements for the vacuum pump, becauee it would be out of the question to have the machine shut down for several days because of the failure of one component. Michel Geay, at Paris-Rhone, limits himself to focusing lenses, tetrodes, filters, and the oil pump.

All these drawbacks have not, it seems, been enough to shake the enthusiasm of the users, practically all of whom are thinking about getting a second machine. Two of them have already taken steps in that direction. At the end of December SNIAS of Marignane will install a new 1-kW laser, faster and more accurate. A few weeks later it will be Paris-Rhone's turn, as they will begin using an entirely automated machine with robots for feeding and removal of work and offering production rate twice that of the present equipment.

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AUTOMATION AT ASEA ALLOWS UNMANNED SHIFTS

Stockholm NY TEKNIK in Swedish 10 Dec 81 p 28

[Article by Sven-Olof Carlsson]

[Text] ASEA [Swedish General Electric Corporation] in Helsingborg is one of the Swedish firms that have had long experience with unmanned production using industrial robots.

There are three robots in two machining groups for the production of gear housing components for electric motors.

If necessary, the production groups can be used for unmanned extra shifts.

Ingemar Axberg, head of production engineering, says: "It is most profitable for us today to operate unmanned on regular shifts. Our workload these days, like that in the rest of the engineering industry, is such that there is not much need for extra shifts."

ASEA in Helsingborg has several lines for the production of electric motor gear housings. The gear housings are produced in various sizes, and it is the smallest types in the largest lot sizes that are manufactured partly by unmanned production.

The line where the industrial robots are used is designed to produce 35,000 gear housings annually, a figure that is not being reached today.

Two industrial robots are used in one production group to machine castings, and one robot is used in another production group for machining shafts. The production groups take 2 minutes to do the work that used to require three-quarters of an hour manually, despite the mass production system.

The Helsingborg factory also has an automatic painting line that uses a Norwegian Trallfa robot. There the gear housings are painted after final assembly or after being mounted on the electric motors. The painting robot is programmed for all types and automatically changes its program and movement pattern.

Ingemar Axberg says: "For each machining group, we have input and output hoppers large enough to keep the unmanned operation going for a few hours. If necessary, we can easily enlarge the hoppers and operate unmanned for a whole shift."

Long Experience

The Helsingborg factory put its robot production groups in operation in 1977, and its experience with NC [numerically controlled] machines goes back even farther than that. The first NC machines went into service in 1964, and about 30 are being used today.

Ingemar Axberg says: "The robots and the stroke transfer machines--which carry and hold the parts to be machined--have high availability. There are a few more problems with the NC machines, so they determine the availability of the machining groups as a whole.

"But we have reduced the failure rate and set-up times by using a system in which we change the entire tool unit in the machines and not just single drills, milling wheels, or grinding wheels.

"We also have a maintenance schedule in which operating time and wear are closely followed so that we can have the tool changed before it runs the risk of breaking down."

Utilization of one of the machining groups has increased, incidentally, in terms of the original sequence chart.

During what used to be idle time, a grinding machine can now grind down close surfaces on the shafts while the other machines are going through their cycles.

Retraining

When the robot production groups were introduced, the result was sharply reduced manpower requirements for the production of small gear housings. Manual production required 13.5 persons for the machining of castings. Only 2.5 persons are required today. In the case of shaft machining, the reduction was from 5 to 1.5 persons.

Ingemar Axberg says: "Since we have manual production on the lines for larger gear housings, we were able to transfer people to those lines. Some were retrained to operate the robot machining groups. That, combined with natural attrition, has meant that we have not had to lay anyone off due to the introduction of robots."

How It Works in Helsingborg

The production line for small gear housings has two machining groups in which ASEA's (60-kilogram) industrial robots are employed--one for machining castings and one for machining steel for shafts.

The production group that handles castings has two subgroups, each with its own robot. In one machining group, two components of the gear housing--the gear cover and the plate--are machined. The robot controls three special machines that mill, drill, tap, and burr and a gaging station that remeasures the cover and plate in a total of 14 operations. This has reduced the number of manual operations to 6, compared to the 46 that were required when the work was done manually.

In the second machining group, one robot controls three special machines and a gaging station in a total of 11 operations for the machining of shields for the gear housings. The number of manual operations is now 4, compared to 36 before.

From those two casting machining groups, the gear housing components go to a washing station and then to final assembly.

In the first of the casting machining groups, however, a simple assembly and disassembly operation takes place completely mechanically. The industrial robot places the cover and plate in chucking fixtures, where they are automatically screwed together, then machined and gaged in five operations before being taken apart again to go to the washing line.

The machining group that turns the long shaft blanks into shafts for the gear housing's gear wheels also has an ASEA (60-kilogram) industrial robot for machine control. The robot moves and holds the shafts being machined in a crosscut-centering machine, a numerically controlled lathe, a keyway milling machine, and an NC grinding machine, as well as two gaging and testing stations.

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SCIENCE POLICY

PROVISIONAL PLAN FOR RESEARCH, TECHNOLOGY OUTLINED

Paris AFP SCIENCES in French 17 Dec 81 pp 1-5

[Text] Paris--The provisional plan for research and technology: An "unprecedented and immediate" research effort is envisaged by the 1982-1983 provisional plan for recovery of research and technology.

In fact, as Marc Albouy, head of the study and research department of the General Planning Commission, stated to the press, "it establishes the strategy that will make it possible, in the medium term, to be on a possible, necessary course, so that the national expenditure for research and development (R/D) will reach 2.5 percent of the gross domestic product (PIB) in 1985.

In order to attain this objective, the reporters of the plan believe that, "in spite of the outlay made by enterprises, it is not possible to prevent public financing for research and development from taking a preponderant part." Thus, civil financing of the administrations will represent, in 1985, close to 50 billion francs of the national expenditure of 80 billion francs. The state's outlay alone will, therefore, represent the equivalent of the present national expenditure. The present national expenditure is broken down into 30 billion in the public sector and 20 billion in industry." Nevertheless, maintenance of the share in research and development carried out by enterprises "is a necessity and the objective in 1985 is for this share to increase from 1.1 percent of the PIB today to 1.5 percent.

This objective will bring with it "a very considerable increase in the financial transfer by administrations to enterprises." Thus, if enterprises performed research and development in 1980 amounting to 30.2 billion francs and financed 21.7 billion, or a transfer of 8.5 billion in their favor--distributed among military administrations (4.9 billion francs), civil administrations (1.9 billion francs) and foreign orders (1.7 billion francs)--in 1985, if they perform research and development amounting to 48 billion francs (1.5 percent of the PIB) and finance around 30 billion of that amount, the financial transfer in their favor will amount to some 18 billion francs (in 1980 francs). In view of the military growth and anticipation of orders coming from abroad, it can be estimated that the net balance of the transfers between civil administrations and enterprises should amount to between 8 and 9 billion 1980 francs, or an increase of around 7 billion francs in 5 years.

There are several means of action for achieving these transfers, in particular large-scale technological programs and incentives for industrial research. The annual progression needed for this double objective is estimated at 26 percent, on the average. The plan puts much emphasis on the need for promoting a policy of bonus aids to the hiring of scientific personnel in enterprises and for giving priority to a policy of tax incentives for this same purpose.

In addition, banks and industrial enterprises will be encouraged to set up new innovation finance companies and risk capital companies.

In any case, basic research is not neglected, quite to the contrary, and Hubert Curien, chairman of the Technological Research and Development Group of the 2-year plan and, in addition, president of the the National Center for Space Studies, has insisted on stressing it. The plan provides, in fact, for "an improvement in means for basic research, which are going to increase by over 50 percent in 2 years with regard to operational credits alone." Better recognition should be given to the research activity of instructors and it should be better organized. During the 2-year plan, the reporters point out, reflection should be applied, in order to become better acquainted with the research activity of instructors in the universities, the large establishments of the specialized professional schools and of the IUT's [University Institutes of Technology].

Moreover, the plan recognizes the "absolute need" for increasing the number of researchers by 4.5 percent a year. Finally, a certain degree of acceleration of large-scale equipment is suggested.

It is observed that the 1982 research budget, which has just been approved by Parliament, agrees with the "course" proposed by the plan and that the scientific and technological programing and orientation law, to be submitted for examination by Parliament in the spring 1982 session, will undoubtedly be inspired considerably by the objectives and means appearing in the provisional plan.

In the opinion of Pierre Frederic Teniere-Buchot, head of the Future Planning Division of the former DGRST [General Delegation for Scientific and Technical Research], "many things should be watched. This is the first time that system analysis is used."

Thus, for example, the objective of 2.5 percent of the PIB has been established. It is obvious that, in order to attain it, it will difficult to deviate appreciably from the projections made. For 1982, it has already been determined. And for 1984, the number of variants will remain low.

In conclusion, the plan proposes some thematic observations on research and technology.

Among the research sectors to be improved, the plan believes that "a revival of the human, economic and social sciences," "a great effort in behalf of culture," and so on are needed.

In the field of health, research should favor four main lines"

[1.] Public health (epidemiology, sociology of health.

[2.] Biomedical technologies and logistics (biological and medical engineering, biological and medical data banks).

[3.] Clinical research.

[4.] Prevention, especially in the areas of nutrition, labor and highway accidents, alcoholism and nicotinism.

Research on aging (secondary disability with cronic, pathological disease of old age, medical consumption by the elderly), on mental illnesses and mental handicap, would deserve encouragement.

In the field of civil aeronautics, the plan proposes new investments pertaining to the national expenditure plan for research and development in 1985 corresponding to the objective established by the government depending on the growth of the gross domestic product envisaged up to 1985.

Two economic growth assumptions starting in 1983 were studied. One, an average of 3 percent over 4 years (1981-1984). The other, great growth averaging 3.5 percent over the same period. They lead to the following tables:

	1980	1981	1982	1983	1984	1985
Growth rate of the PIB in volume						
a. Low assumption		0.5	3.3	3.7	3.7	3.7
b. High assumption		0.5	3.3	4.6	4.6	4.6
PIB in billion 1980 francs						
a. Low assumption	2,754.9	2,768.7	2,860.1	2,965.9	3,075.6	3,189.4
b. High assumption	2,754.9	2,768.7	2,860.1	2,991.7	3,129.3	3,273.3

The following is the desired evolution for the DNRD [national expenditure for research and development] / PIB ratio:

	1980	1981	1982	1983	1984	1985
$\frac{DNRD}{PIB} \times 100$	1.83	1.89	2.05	2.20	2.35	2.50

Therefore, the following evolution of the DNRD in billions of 1980 francs is obtained:

	1980	1981	1982	1983	1984	1985
DNRD (projections)						
a. Low assumption	50.5	52.2	58.6	65.2	72.3	79.7
b. High assumption	50.5	52.2	58.6	65.8	73.5	81.8
Difference (a-b)	0	0	0	0.6	1.2	2.1

Calculation of the growth rates of the DNRD, in volume, leads:

Under the low assumption, to +11.1 percent in volume, on the annual average.

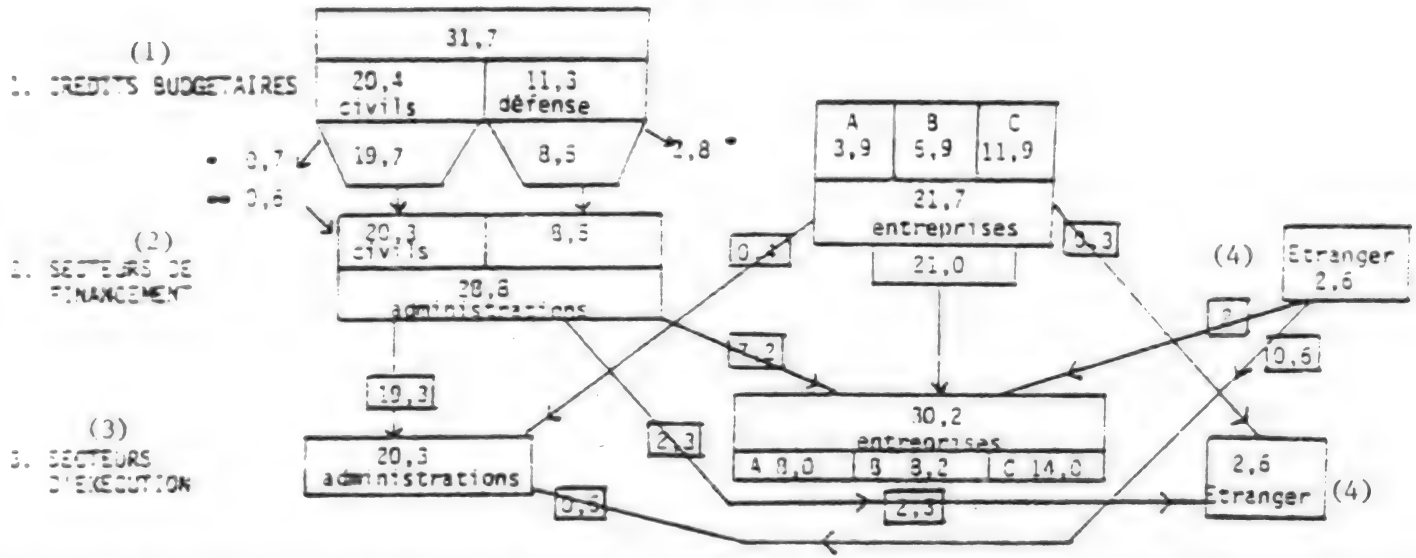
Under the high assumption, to 11.8 percent between 1982 and 1985.

The low assumption was decided on for the rest of the calculation. At any rate, the low degree of sensitivity of the result will be noted: around 80 billion 1980 francs, in 1985, with a relative error of ±2.5 percent.

The financial outlay, cumulative over 5 years, needed for increasing from 1.8 percent of the PIB in 1980 to 2.5 percent of the PIB in 1985 amounts to close to 60 billion 1980 francs. This amount relatively independent of the PIB growth rate shows the extent of the outlay to be made by the collectivity.

[Diagram and tables on next pages]

Year 1980 (in billion francs)



Internal Expenditure for Research and Development (DIRD) = 20.3 + 30.2 - 50.5 billion francs
National Expenditure for Research and Development (DNRD) = DIRD + National Financing of research performed abroad - Financing abroad of research performed in France = 50.5 + 2.6 - 2.6 = 50.5 billion francs = 1.83 percent of the PIB.

A: public enterprises
B: Groups capable of being nationalized
C: Other enterprises
(1) Status of statistical knowledge in September 1981
* VAT billed to administrations by enterprises and miscellaneous repayments
** Own resources of agencies deducted from public financing

Key:
1. budgetary appropriations
2. financing sectors
3. execution sectors
4. abroad

Estimate of 1982-1985 Expenditures

Milliards F. 1980 (4)	(1) Années de référence 1980	1981*	(2) Plan de deux ans 1982	1983	(3) Accroissement Moyen Annuel 1983/1981	Horizon 1985 1985	(3) Accroissement Moyen Annuel 1985/1991
DNRD							
FINANCEMENT INDUSTRIEL (5)	50,5	54,7	58,6	65,2	9,1 %	79,7	+ 9,8 %
FINANCEMENT PAR LES ADMINISTRATIONS (6)	21,7	22,2	23,5	25,3	6,8 %	29,6	+ 7,3 %
	28,8	32,5	35,1	39,9	10,8 %	50,1	+ 11,4 %
CP + DO (7)							
FINANCEMENT BUDGETAIRE DONT : (8)	31,7	36,4	39,4	44,8	10,9 %	55,6	+ 11,2 %
.FINANCEMENT MILITAIRE (9)	11,3	13,3	13,9	14,2	3,3 %		
.FINANCEMENT DES ENSEIGNANTS-CHERCHEURS (10)	3,2	4,2	4,5	4,9	8 %		
.P.T.T. (11)	1,1	1,7	2,1	2,3	16,3 %		
.AUTRES FINANCEMENTS CIVILS (12)	0,2	0,3	0,3	0,4	15,5 %		
.BUDGET COORDONNE PAR LE MINISTERE DE LA R ET T. (13)	15,9	16,9	18,6	23	16,7 %		
.EIR + PDT ET IRI) (14)							
AP + DO (15)							
FINANCEMENT BUDGETAIRE DONT : (8)	34,3	39,4	42,9	48,5	10,9 %	60,4	+ 11,3 %
. FINANCEMENT MILITAIRE (9)	13,1	15,4	15,5	16,3	2,9 %	17,3	+ 3 %
. FINANCEMENT DES ENSEIGNANTS-CHERCHEURS (10)	3,2	4,2	4,5	4,9	8 %	5,4	+ 6,5 %
.P.T.T. (11)	1,4	2,1	2,5	2,7	13,4 %	3,5	+ 13,5 %
. AUTRES FINANCEMENTS CIVILS (12)	0,2	0,3	0,3	0 4	15,5 %	0,6	+ 18,9 %
.BUDGET COORDONNE PAR LE MINISTERE DE LA R ET T (13)	16,4	17,4	20,1	24,2	17,9 %	33,6	% 17,8 %
.EIR + PDT ET IRI) (14)							

* Estimate after changing base.

Key:

1. reference years
2. 2-year plan
3. average annual increase
4. billions of 1980 francs
5. industrial financing
6. financing by administrations
7. [expansion unknown]
8. budget financing, including:
9. military financing
10. financing of instructor-researchers
11. Postal, Telegraph and Telephone service
12. other civil financing
13. budget coordinated by the Ministry of Scientific Research and Technology
14. [expansion unknown]

Estimate of 1980 Execution
(billion francs)

	(1) Par les Administrations		(2) Par les Industries			(3) Par l'étranger	(4) Financement total
	Civiles & Militaires (5)		Nationalisées (6)	Nationalisables (7)	Autres (8)		
Administrations civiles (9)	15,8		1,2	0,5	0,4	2,3	20,3 40,2 %
Administrations militaires (10)	3,3		2,8	1,2	1,0	-	8,5 15,8 %
Industries nationalisées (11)			3,9	-	-	-	3,9 7,7 %
Industries nationalisables (12)	0,1		-	5,6	-	0,2	5,9 11,7 %
Autres industries (13)	0,3		-	-	11,6	0,1	11,9 23,6
Financement de l'étranger (14)	0,5		0,1	0,8	1,1	-2,6 / +2,6	50,5 100 %
Exécution totale (15)	20,3 40,2%		8,0 15,8%	8,2 16,2%	14,0 27,7%	DIFD= 50,5 100%	DNRD = 50,5 + 2,5 - 2,6

(16) Financement

43 %

50 %

Key:

1. by administrations
2. by industries
3. from abroad
4. total financing
5. civil and military
6. nationalized
7. capable of being nationalized
8. others
9. civil administrations
10. military administrations
11. nationalized industries
12. industries capable of being nationalized
13. other industries
14. financing from abroad
15. total execution
16. financing

TRANSPORTATION

ROBOTIZATION INCREASES AMONG FRENCH MANUFACTURERS

Paris L'ARGUS DE L'AUTOMOBILE in French 31 Dec 81, 7, 14 Jan 82

[31 Dec 81 p 3]

ROBOT CENSUS

[Text] Many Frenchmen are convinced that the Japanese automobile industry outclasses our own owing to an army of robots. This idea must be done away with and the fact loudly proclaimed that we have nothing to be ashamed of with respect to our own robots, either as regards their quality or their number.

A Myth To Be Exploded

A recent survey by the CSCA [Automobile Builders Syndical Chamber] counted, as of mid-1981, exactly 16,898 robots in service in Peugeot, Talbot, Citroen, Renault and UNIC [expansion unknown] plants.

This figure has now been greatly exceeded. But then, why is it that certain "experts" credit us with only 400 robots as compared with 50,000 Japanese ones? The answer is simple: We are not talking about the same robots! While for the French the "robot" is a state-of-the-art machine, highly developed and performant, the Japanese bestow the term "robot" on what to us is a mere automated machine... Using the Japanese terminology, we have at least 17,000 robots (compared with their 50,000) of a quality equal to and in certain domains (recognition of shapes, shapes, smelting, etc) superior to theirs.

Peremptory affirmations of our mediocrity have created a wave of panic in the public mind. However, after having visited the plants at Mulhouse (Peugeot), Billancourt, Douai, Flins (Renault), Poissy (Talbot), Charleville and Velizy (Citroen) and interviewed, over the past 7 months, the builders' technical managements, we can assert that, thanks to our robots and a number of other factors, our industry is now regaining its competitiveness on the world market.

To Have Done With It...

It is worth pointing out that Japanese industry has broadened the meaning of the term "robot"...to benefit to a greater extent from the bonuses and tax advantages

offered by its government as an incentive to modernization of the country's productive apparatus. (In fact, why has not the same thing been done in our own country?). At the risk of sounding as though we are "cock-a-doodling," we would also point out that the Japanese automobile builders' plant equipment, installed between 1960 and 1970 during the worldwide automobile boom, will be modernized now at a slower rate, enabling us to catch up with them. Added to this is the interest currently being shown by the Japanese in certain French robotics techniques, which are far more advanced than theirs...

To put to rest once and for all the psychological aspect of the problem, we shall mention what the "Japanese obsession" has produced of a positive nature. The facile thesis of low costs owing to the low remuneration of workers or exploited subcontractors, and to hellish production rates, has definitely run its course. A revaluation of the yen and a price rise on the European market were all it took for us to realize "that we were not all that far ahead of them," and that their manufacturing, and above all their management, methods--which we were convinced we knew and were equaling--were in fact superior to ours. Our "mea culpa" was rapid, and our reaction equally so: The erstwhile poor-copiers opened their doors wide to the French, who in turn lost no time in copying from them...and in improving whatever could be improved. Thus, a new kind of exchange was created--one less embittered by passions, and more durable and fruitful for all.

Classifying "Automatons"

There is little point in speaking of robots per se. They must be put back into proper context, namely, that of automation of production. Currently, they represent the summit of a hierarchy of machines, the first-born in the immediate postwar period, neatly grouped, according to the "Japanese" system of classification, into four categories, based on the method of programing used:

A. Manually controlled manipulator: A machine that reduces human effort or distances it from a harmful environment. Its programing is actuated by the human effort involved.

B. Fixed-sequence-controlled manipulator: A machine that operates according to a preset sequence (always the same motion(s)) that is not rapidly reprogramable. Many such machines, controlled by cams, templates or simple, hard-wired electronics, have been in use for several decades in our plants.

C. Programable-sequence-controlled manipulator: A machine whose preset sequence is very easily and rapidly reprogramable. At this level, the term "robot" actually becomes applicable: This category includes the numerous "painting" robots that can recognize different vehicles on an assembly line and spray their electrostatic paint (via mini-cups rotating at 40,000 rpm) in accordance with the shape they have recognized.

D. Learning manipulators: This is the highest form of robot, very often anthropomorphic in aspect (resembling a human), with shoulder, forearm, wrist and hand. It is programed by recording manually controlled motions and is capable of immediately repeating the motions thus "learned."

The Robot Concept

In this classification, the "European" definition of robot is clearly discernible in terms of categories C or D. Such a robot differs from the other manipulators (A or B) by four main functions:

1. Ability to learn a behavior pattern, a specific task, or a type of job--for example picking up one or several objects (or tools).

2. Ability to analyze, to perceive an environment, via sensors; this touches on the concept of artificial intelligence.

3. Ability to process the information thus gathered. The complementarity of functions 2 and 3 is evident, enabling the true robot to measure physical quantities, process them and compare them with typical values learned.

4. Possibility of modifying its "type" learning, hence the importance of "geometrical" control.

Though it cannot be called intelligent machinery (Wherein does its intelligence lie, although there is a certain grasp of relationships?), the robot does have, within the range of activities in which it is positioned, a certain autonomy of decision. It can adapt its intervention to the type of problem it encounters, but will refuse any activity outside the field of its acquired knowledge.

Multiform Robots

At the borderline, a case could almost be made for creating a B' category midway between B and C, for certain dually programed machines having a fixed sequence (its principal one) and a variable sequence. This primitive robot clearly has the appearance of an industrial automaton, quite antipodal to the "humanlike" aspect of a D robot. This is also the case of C "type" robots: How does one recognize a robot--educated to them as one is by science-fiction movies--in a series of "minicups" spewing out a fog of paint, or of traveling gantries equipped with spray guns, painting everything that passes in front of them...?

The "D" robots are characterized by:

1. Their morphology: Horizontal, vertical, telescoping horizontal, telescoping vertical, gantry, elephant-trunk vertical robots.

2. Their motive-power medium: For heavy loads (80 kg for Renault), a hydraulic-drive system is preferred, but wherever possible (around 40-50 kg for Talbot), electrical drive is preferred. For light loads--5-8 kg--everyone without exception prefers electrical drive.

4. [as published]. Their degrees of freedom: Let us take the most "picturesque" case--the 6-degree "vertical" robot--which also most resembles a human. The first of its six degrees is the ability to advance so as to approach the workpiece. The second is provided by the rotation of its trunk. The third, by articulation

of its shoulder, which permits its arm to rise or descend and which, combined with the first and second, enables the forearm-hand assembly to be brought up to the workpiece on which it will operate. The fourth, fifth and sixth degrees characterize the hand: up-and-down motion, right-left-right motion, and rotation of the wrist. On certain "elephant-trunk" robots, a seventh axis is added, giving it greater flexibility and enabling it to paint the interiors of automobile bodies.

5. Type of manipulation performed: This may involve parts (payload and volumes are of course taken into account) or tools or both: Certain robots position a part in place, then change their (pneumatic) part-handling "hand" for a tool "hand" (a welding one for example) and carry out their intervention. For reasons of efficiency, however, robots are being made more and more special-purpose.

6. In the very near future, a sixth criterion will have to be added, based on the capabilities of its sensors and the power of their software: Renault has introduced robots capable of recognizing complex shapes (TV camera, sonar) and of lining up parts in a given order. From the mechanical standpoint, these robots are no different from conventional manipulator robots, but "intellectually" (sic)--to finally use the term--they are far superior.

Learning and Animated-Drawing Techniques

Whether electrically or hydraulically driven, robots, mechanically speaking, are nothing more than machine tools: They obey the same laws of obsolescence and have therefore a useful life of 15-20 years. It would have been possible to build them as far back as the early 1950's; however, the electronic computer, which today weighs 300 grams, would at that time have weighed 30 tons (30 million grams!) and would hardly have been fast enough operationally...putting the robot outside the realm of profitability.

Today's microcomputer is at one and the same time the nerve system and the brain of the robot. How does it learn the work to be done? The method uses the animated-drawing technique in which drawings showing successive stages of a motion are photographed frame by frame on motion-picture film, so that when the film is projected at normal speed a continuous motion is produced.

1. By means of a "push-button box" resembling a conventional remote control and acting directly upon the robot, a technician causes the robot's members to move while breaking down the movement into constituent stages. All these operations are recorded on a magnetic tape. When this tape is run at an appropriate speed, the motion conveyed is rapid, continuous, but always precisely the same. It can be repeated hundreds or thousands of times (unless the cassette or program is accidentally erased), subjet only to the machine's durability (which must not be overestimated) and to proper management of wear and tolerances.

2. To gain time, the buttons have been replaced with a whiffletree, making the work of the learning-cycle technician easier.

3. To further gain time, a "jumping jack" is used. This device, in the case of painting, for example, has the same geometry (identity of segments, volumes and articulations) as the robot. A technician puts it through its motions in the most efficient manner possible; all the motions are recorded on a magnetic tape. When he feels he has perfected the operation, the cassette is inserted into the robot, which, a few minutes later, reproduces the best motions of the technician. It should not be thought that this easy: At Aulnay (Citroen), the painter did 1,000 automobiles before being satisfied! But how comforting it is to know that an exceptionally perfect human performance will become the robot's routine; the big winner in the game is the customer...but, concomitantly, the builder as well.

4. The computer can also be programed directly via a display console in dialogue with the robot; this is a much easier way to do it than it might seem to be...and offers great promise for the future.

Where Do the French Stand?

The survey conducted by the CSCA provides some useful information. Among the French builders there are 2,247 robots of the A type, 8,777 of the B type, 5,325 of the C type, and 369 of the D type. Precise data are hard to come by: Renault claims to have 200 type D among 8,000 machines, 4,632 of which are for automobile production, and estimates that PSA [Peugeot, S.A.] has about the same number; Talbot lays great emphasis on its in-house production of robots, its six new type-D robots baptized "Barnabe" and its numerous UTAP's [Programable Translational Units], classifiable as types B, B' or C and which have been in operation for many years; and at Sochaux and Mulhouse, so much secrecy surrounds robotization (which is nonetheless real, however) that a superb robot which removes engine blocks from the automatic injection presses and checks their conformity to specifications is, for security reasons, entitled only to the designation of "automaton"! At Citroen, on the other hand, the figures are ultraprecise: 650 type A, 950 type B, 1,350 type C and 50 type D are in service in the group's plants.

One fact comes to the fore: The robot population of our builders is highly performant (because it is recent!) and equitably distributed within the two groups. This will come as a surprise--the ransom price of the multiplicative effect of television--to those who think Renault is the only one that has robots in large numbers. It is also generally believed that the Regie is the sole manufacturer of automobiles that also manufactures robots, whereas, paradoxically, all the French manufacturers follow the same policy, as we will actually see later.

The Golden Age

In the trend toward automation of manufacturing processes, the robot is sometimes the best choice of the moment, but it will necessarily be so in the future. Citroen is going from 3,000 robots in 1981 to 4,850 by 1983; the others are increasing their robot populations in about the same proportions. The "sometimes" may come as a surprise to some, but contrary to the commonly accepted notion, it

is not necessarily true that the replacement of body-welding machines, for example, by robots is today the most economical choice. Once again, we must go back to the source--to the revival of automation and of our automobile industry, in 1945--for an explanation of this phenomenon.

World War II had seen the development of servomechanisms for radar management and control functions. With the return of peace, automation techniques came into widespread use in continuous process (oil refineries, chemical plants) but much less so in discontinuous processes. Nevertheless, progress was real and crowds gathered to watch the first transfer machines, the various automatons, the "multipoint" welding machines... A market in continual expansion made the automobile a "pull product" (a product that is "pulled" by the market, its producer needing only follow), and productivity underwent considerable development--a relatively easy process based on the series-production methods of that time--through rational juxtaposition of various devices: electrical, pneumatic, hydraulic, or mixed.

This golden age came to an abrupt end in 1972 with the first energy shock wave.

Death of the Dinosaurs

Overnight, the automobile became a "push product," a product that must be "pushed to sell"--that must be attractive, reliable, but above all, in constant evolution to preserve its allure. All of a sudden, production tooling was found to be monstrously rigid, incapable of reacting flexibly, and unsuited to the new era.

Fortunately, electronics and data processing are now providing support to the industrial sector and are able to impart indispensable flexibility to production techniques, through the use of universal machines that are smaller, instantly adaptable, and able to build several different models on the same assembly line. The dinosaur-like robots died as soon as their environment changed; the "multipoint body welders" are doomed. True, they are highly proficient; but they are enormous, costly, made in quantities of only one or two at most per model, and unable to produce more than one model. If that model is discontinued, the sumptuous machine cannot be adapted to the model that follows: It must be returned to the foundry!

With the life-span of models growing ever shorter--7 years today versus the 10, 12 or 15 years (sometimes more) of not long ago--the "multipoint" can no longer pay for itself.

The new robot, on the other hand, will produce at least two models, for a total life-span of some 15 years: A steelwork change to fit a new model will cost 50 percent less. A simple cassette change (a few minutes), a new control program, and immediately it is welding a new model. A "face lift" (a retouching of the front end) or a "restyling," should they be called for, present no problem: The robot (its software modified) easily adjusts to the slight differences involved. This important principle of "flexibility" granted, the massive entry of robots into production plants is justified by still other criteria.

Robot Welder = Quality

The irreversible nature of automation--hence its most advanced form, which is robotics--stems from requirements of threefold origin: technical, economic and social.

With competition playing its part, quality has become the main concern of the automobile builders; the development of automation contributes to it. The most striking example is that of the spot (induction) welding of bodies. The job of the human spot-welder is a hard one despite all efforts at electrode balancing; the slightest deviation from exact perpendicularity of the electrodes to the sheet metal is sufficient to prevent the "point" of fusion from being perfectly round and impart to it any of various "crescent" shapes. The duration of passage of the low-voltage current is generally well calculated as a function of the thicknesses involved; however, a melting down of the steel sheet(s) throughout the area of the "crescent" can occur. Furthermore, there being no certainty as to the precision (positioning-spacing) of the "spots," they are multipled, so that, in a worst-case situation, the assembly will still have the required strength.

With automatons, the problem is resolved: Precision is within 0.7 mm (Talbot), quality of the welds is regularized, and the number of "spots" can be diminished. One of the major advantages of the Japanese is that they have been able to bring the number of "spots" down to about 25 percent (around 1,000) of ours, and thus to reduce their costs accordingly...but Talbot, having already come down to 3.20 [as published] "spots" for the Samba, thinks Citroen can still do better!

Increased product reliability is therefore a direct consequence of robotization; however, it should be pointed out that, for certain small parts, the older automatons continue to be more viable...even though they cannot change from one fabrication routine to another as rapidly as the robots: The best example comes from Rennes, where 60 percent of the GS's spot-welds have been "automated," while 95 percent of the GSA's have been...but not necessarily thanks to robots!

Costly But Economical

A robot is by definition a "person who does not tire," who can work 24 hours a day, 7 days a week, without ever taking a vacation. The reality is much more complex, for fatigue and illness exist for machines as well, robots or not. This is in fact one of the criteria governing the choice of robots; at Poissy, had Anatole, the first robot to be built in-house, and its offspring, Barnabe, not reached a profitability threshold--1,300 "spots"/hr on 400-500 parts/day, and a 1-percent rate of outage time--they would no longer be in existence , nor would they have descendants.

If it is productive, the robot is above all flexible and enables production to be adapted to the evolution of the market, so that should one model "crumble" from the sales standpoint and another unexpectedly "take hold," overall production can continue at an identical rate. If the plant is unable to shift production rapidly from one model to the other, it will lose sales and revenues. Its

speed of reaction will moreover not depend solely upon its stripper, conveyor, transfer, welding, painter or even assembler robots. The entire workshop must be flexible. This requirement, this operational flexibility, demands the creation of hierarchical systems, of managing robots of a sort.

These are the least spectacular, but with them it is possible to save energy, reduce stocks, work out economical batchings, etc--in short, carry out with unprecedented speed the functions required to operate the production unit in the most intelligent manner possible. The "push-button" plant is no longer a myth. The Citroen foundry at Charleville is a perfect example. True, it is crammed with "conventional" robots they are all coordinated interactively at all levels. It is not a mere coincidence that Peugeot has made of it the pivotal point of its developmental work on foundries and that Japanese and Americans are buying certain patents...

[7 Jan 82 p 3]

SOCIAL FACTOR

[Text] The third factor in the irreversibility of automation is social. Had the energy crisis not accelerated the process, the need to improve working conditions would have produced the same result. All the automobile makers are determined to eliminate heavy, difficult, repetitive, hazardous and unhealthy work. The safety of human workers can be vastly improved, though it will never be total regardless of the precautions taken. The definitive solution, the only sure one, is to perform these jobs...without human intervention. Were not the first robots handlers of cumbersome, bulky, heavy and sharp-edged parts? Robotics is making its most rapid advances in foundries (not the machining of parts, for which conventional transfer machines are best suited), iron and steel work, welding, and painting (priming,PVC undercoating of chasses). Personnel working close to robots see their jobs being redefined and more often than not enhanced. The reorganization of work, in symbiosis with robots, clearly marks progress.

Every coin, however, has its reverse side, and the advantages of robotization--its technical, economical and social ones--generate problems in these very domains.

Adapting

Changing the structures of a plant or reconverting it, when possible, is not a minor undertaking. The remarkable "gate-line" assembly lines at Poissy are not robotizable! On the other hand, the Citroen plant at Aulnay was designed with eventual robotization in mind. Not knowing exactly what shape those robots will take, the architects have left vast open spaces to accommodate them... that in the meantime represent a burdensome investment!

Vehicle design techniques must also adapt. A robot can be made to do a great deal; but the simpler its job is made, the more efficiently the robot will perform it. At Douai, during the setting up and adjustment of the R-9 assembly lines, the work of the robots could be compared with that of the personnel working on the R 14. For the same work (joining up the rear body subframe), the robot welded "in line" whereas the human workers had to perform a number of difficult "backstep" welds. For each visible improvement coming out of the design

stage, off the drawing board, there are many others--methods of bending the metal sheets, of assembling them--that are equally important, without forgetting the improved quality of the spot-welds and the reduction in their number. Thanks to the robots, the reduction in production costs, in the final accounting, is placed at around 20 percent.

Costly Robots

On the other hand, certain robots are not directly profitable. This is the case of those made necessary in order to improve working conditions. For some other kinds of production work, their arrival is not being looked forward to, a good transfer machine being far more productive than an army of robots! This points up an important concept: The robot is not a panacea; its profitability is not necessarily greater than that of existing machines, for although it is rapidly amortized (2-2 and 1/2 years) under optimalized conditions, its purchase price is high.

An assemby robot costs (on average) Fr300,000, a painting robot Fr400,000, a welding robot Fr500,000-600,000, a figure that must be practically doubled (80-100 percent) to include the acquisition of its environment.

It must also be considered that a robot can only perform a few spot-welds. At Poissy, the four robots on the Samba subframe assembly line perform 90 spot-welds versus 174 by the automatic machines and 58 by human workers. With time, this proportion will shift toward elimination of the human contribution, but that of the robots will not exceed 50 percent.

In any case, for welding operations, a large number of robots -- and a costly investment--must be envisioned. And since the robots currently available on the market are far from being as universal and reliable as might be imaginable, our builders are being understandably cautious in their selection and thorough in their testing of such equipment...and are building their own in cases where they have not succeeded in finding the rare bird they are seeking!

And What About Unemployment?

From the labor standpoint, the replacement of workers by robots can be summed up simplistically by the statement: The robot reduces the number of employees. To this, those who have some experience in the field reply: Not assuredly. And they easily justify their position.

The first important fact is that, more often than not, robots replace systems that are already automated! In 1969, 50 percent of the R-5's spot-welds were automated. By 1980, this ratio had increased to 82 percent, of which 72 percent was being done by multipoints and 10 percent by robots (in the case of the R-9 and the Japanese vehicles, this proportion is 90-95 percent). From this experience, Renault has drawn the following conclusions: To produce 1,000 R-18 floor assemblies a day requires a staff of 81 workers, whereas for the R 5, whose fabrication is less automated, the production of 1,000 floor assemblies a day

requires a staff of 115 workers. At first glance, one might hastily deduce the disappearance of 34 jobs--an erroneous conclusion since, at the same time, the quality assurance and assembly line maintenance services for the R 18 were increased. In optimum cases, the overall staff has remained constant; in some others, it has even increased!

Conclusions, however, should not be drawn from this state of things, which after all is transitional: When the breaking-in and adjustment period is finally completed, the job-elimination problem, momentarily in abeyance, will resurge.

What is certain, however, is that the fabrication/maintenance ratio will never again be the same: Of every 100 persons involved in steelwork on the R 5, 11.4 are in maintenance jobs, versus 17.4 on the R 18, which is more automated.

Citroen confirms this situation, comparing an old foundry, at Clichy, with a new one, at Charleville. At Clichy, of every 100 persons, 60 are engaged in fabrication, 26 in maintenance, and 14 in technical services, versus 47, 30 and 23 respectively at Charleville, it being understood, of course, that the 47 at Charleville produce as much as the 60 at Clichy.

The Robot and the Social Factor

From the standpoint of qualifications, a corresponding shift toward skills at the upper end of the scale is evident. Of every 100 persons at Clichy, 84.3 percent are laborers, 15.1 percent are staff employees, and 0.6 percent are supervisory employees; at Charleville, these proportions are 74 percent, 24 percent and 2 percent respectively.

Those in the factory labor categories are, as a result of the higher-grade equipment being put at their disposal, also not immmune to this upward displacement of skills: At Clichy, there are 38 unskilled for every 62 skilled laborers; at Charleville, 33.5 for every 66.5, respectively.

From the social standpoint, the effect of robotics will be to:

1. Reduce the number of jobs in the automobile sector (even though it will create more jobs outside it, in the robot-buiding sector).

2. Increase the displacement of skills toward the upper end of the scale.

3. Reduce the proportion of unskilled laborers.

4. Increase the number of permanently employed highly skilled workers.

5. Increase the proportion of production maintenance specialists (including many data processing specialists, which is new), as well as of technicians and engineers.

Between 1950 and 1975, these phenomena, already very real, did not bring about a drop in "direct" employment in the automobile sector: Expansion of the sector

was so explosive that it snuffed out the problem. The Regie expects the disappearance of 12 jobs per 100 at the "Faire" level beginning in the 1990's, for an equivalent productive output, "but it is self-evident that the development of automation is based on the prospect of a substantial increase in production." While optimism prevails at Billancourt, a wait-and-see (or realistic?) attitude is the more evident at Peugeot S.A., where the feeling is: "it is practically impossible to judge the effect of robotics on our employment level."

A secondary--but highly important--effect is that this rise in the level of skills is based on vast programs (and costs) of training. Centuries and technologies are not easily turned round, as Renault well knows, having financed 240,000 hours of recycling in 1980!

[14 Jan 82]

FRENCH-MADE ROBOTS

[Text] The French automobile makers absorbed the robotics "shock wave" very well and reacted intelligently: "We cannot adapt our production tooling to the situation overnight, so let us take a gradual approach, one of selecting the best available equipment."

This very approach, however, actually led to diametrically opposite results. At the time, only Renault had a world standing, the means and the engineering know-how to design and build its own robots, better ones in fact (because better adapted) than those available on the market. This policy of independence and of mastery of the automobile "process" is today bearing fruit, in that Renault has resolved not only the technical but also the economic aspects of the problem. The Regie designs, and has its subsidiaries build, excellent "top of the line" robots (an 80-kg gripper) and "bottom of the line" ones (30 kg, 15 kg, 8 kg) that respond perfectly to its needs...and to those of the other makers. However, it intentionally forgoes the "central" niche in the market, where the "know how"--and prices--of competing products are unbeatable. The recent creation of a subsidiary (Cybotech, with Ransburg) in the United States shows that Renault has mastered these technologies perfectly and is now seeking to turn heavy development costs into profits through exports. Nevertheless, at Flins, only 9 out of 10 robots on the R-18 assembly line are of in-house design and construction: It is continuing to apply the binding principle of selection, based on profitability, of equipment.

With respect to everything that is strictly "production of automobiles," Peugeot and Citroen have found robots at attractive prices and on this basis have no intention of giving up their independence of action in search of productivity. They have therefore not developed their own in-house techniques...although they can be said to have done so in certain cases. Their Asea (Swedish) robots, for example, have been adapted to continuous arc welding (a Citroen patent): Thus, a totally commonplace robot has become an ultra-proficient machine, unique in the world. For its foundry, nothing was available: The Charleville plant was therefore designed from A to Z "in-house" and its organization as well as its robotization are currently the envy of many.

Barnabe

Talbot--Chrysler at the time--had made an early start on automatic welding machines, some of them with dual grippers: They are extremely practical, economical, and can operate during human intervention. The need was felt for "something else" in welding machines, however, the Unimate robot of that time (1973) being nothing more than a mere "handler of materials." The first approach was to eliminate the hydraulics (not clean, not simple, more fragile than it had appeared to be); next, Anatole was created--a heavy-duty, 6-axis (electrically driven) robot that, from 1976 onward, functioned entirely satisfactorily on the 1307-1308 line; and then, in 1978, the Horizon.

Its offspring, Barnabe, is a 6-axis (one translational, five rotational), "fully electrically driven," each axis being powered by a direct-current motor. With its incremental coder, its thyristor regulation, its microprocessor control system, eight programs, 40 kg "at the gripper" (capable of increase to 50 kg), and 20 mkg of wrist torque, it is clearly not universal, but it responds perfectly to the needs of Talbot.

At Poissy, excellent arguments are advanced to justify this choice. The advantage of "in-house" fabrication is that it avoids accelerated aging--the aging built in by the manufacturer to ensure future sales of new equipment (true also in the field of data processing). A second "plus" is total independence: With the assemblers of new foreign equipment spread as thinly as they are, difficulties have at times been experienced in clearing equipment failures. With Barnabe, French-built even though the Inland motors (military specifications, U.S. license, Irish manufacture) and reducer drive gearing (FRG) are foreign-made, there is the assured availability of a reliable product, a not very expensive one (each of the six robots costs Fr500,000), and one that lends itself to future development. The third of three advantages is that solid maintenance personnel is trained at Poissy itself, which perhaps explains Barnabe's excellent record of reliability.

The Future

The group factor also favors Barnabe. A unit was recently shipped from Poissy for an evaluation at Sochaux, and then to Citroen (at Velizy, where a Kuka welder is currently being tested), to be returned "fully used and proven" in May. Does this mean that, in the more or less distant future, Peugeot S.A. will become its own supplier of robots? That would be going a bit fast, for the group's policy is still "Buy the best there is." To this effect, joint procedures have been worked out that are to be applied with equal rigor to Barnabe. This having been said, it must nevertheless be said also that there is no hesitancy about buying from Renault, as attested by Citroen's welding robots at Vigo: Always buy the best there is...

At Renault, plans are as realistic as they are grandiose and concern the designer as much as they do the user of robots. The Douai plant has surpassed the Japanese, in that, in addition to its 125 welding robots, it has "assembler" robots that assemble the R-9's power plant, brought by 110 wire-guided carriages, on the

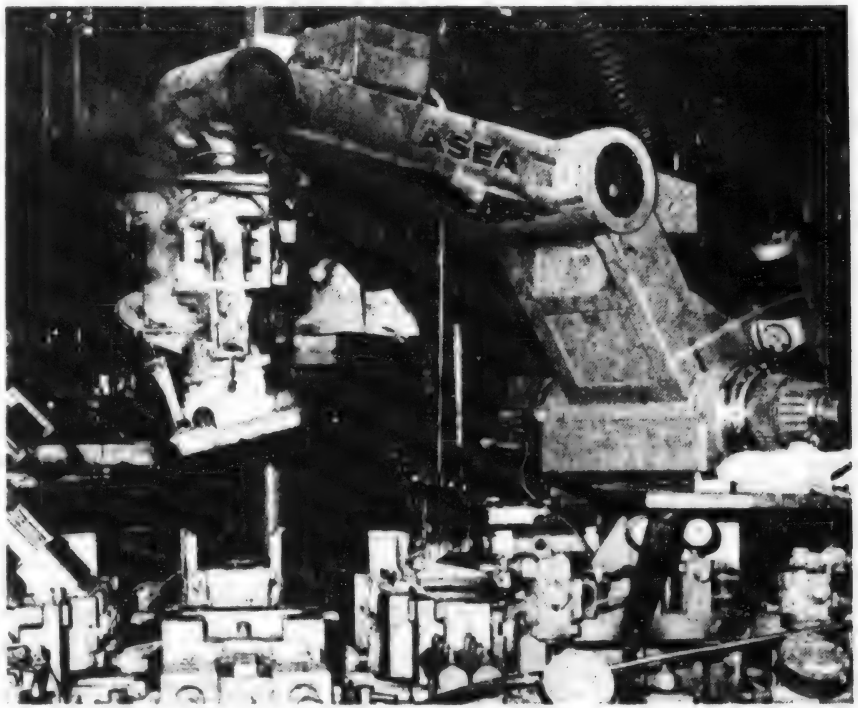
body shell. This is a worldwide "first," in that a robot had never until now "manned" a production-line assembly station. Very soon, however, this feat is to be carried much further. At Billancourt, we saw a robot assembling transmission gearboxes! The machine, a definitely very simple one from the mechanical standpoint, designed for Cleon and Spain, took 3 years to perfect: It stacks bearings, gears and clips on the secondary shaft, without a mistake and with extreme reliability. It functions only, however, by taking the parts on a small carriage with four vertical pins, making it necessary for someone to prearrange the parts in proper order. In the near future, the latter operation will be performed by a robot! The Regie has done a great deal of work on small manipulator robots capable of recognizing shapes, hence to perform such functions. A large 80-kg robot is even equipped with an optical system (a TV camera) backed by a sonar. A sophisticated analysis of images by the robot's software enables the robot to determine how the crankshaft blanks are arranged (on a pallet) and at what point they can be gripped to place them on the conveyor of a transfer line.

Better yet, by improving still further their sensors and softwares, robots can handle parts of greater complexity and even eliminate defective ones... Such investments could appear to be not economically viable; this, however, would be losing sight of the fact that robotics has as one of its objectives the elimination of nerve-wracking repetitive tasks.

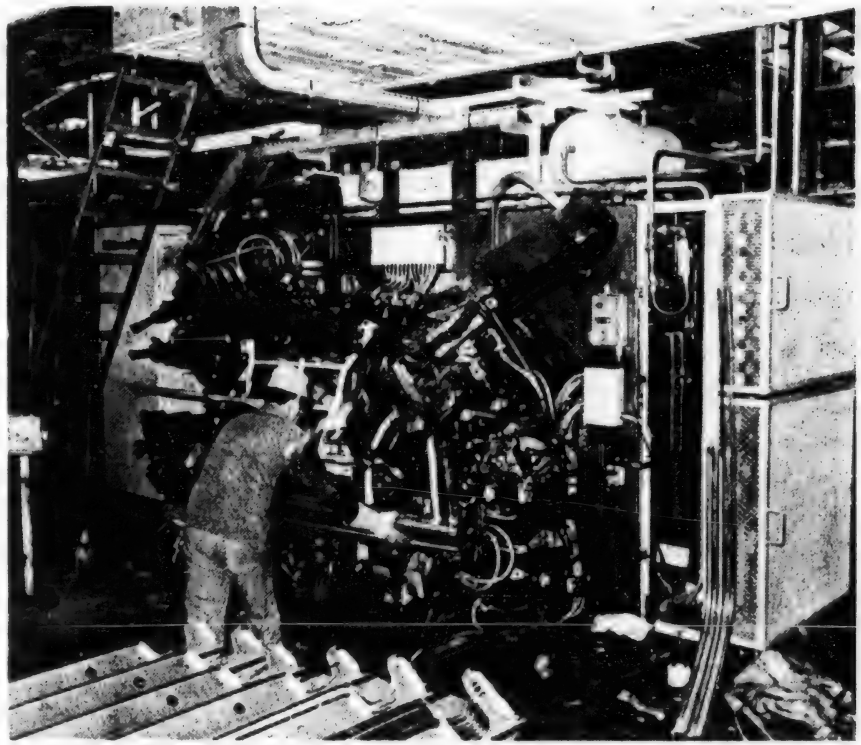
By Way of Conclusion

This third generation of robots, in the light of the growing complexity of the jobs it can perform, is evidence that we are as yet in the prehistoric era of robotics! The designers say they are still being hampered by the slowness of their computers, but this obstacle is due to disappear shortly: This is being worked throughout the world and above all...in Japan. Be that as it may, Renault has become one of the world's leaders in robotics. Peugeot S.A. could rank next to it, were it not that it finds it simpler to build only those few robots it is interested in building and to buy elsewhere--at times from Renault--those it deems the best available. One thing is certain: All our automobile makers use robots judiciously, from the economic standpoint as well as from the social one. Q.E.D.

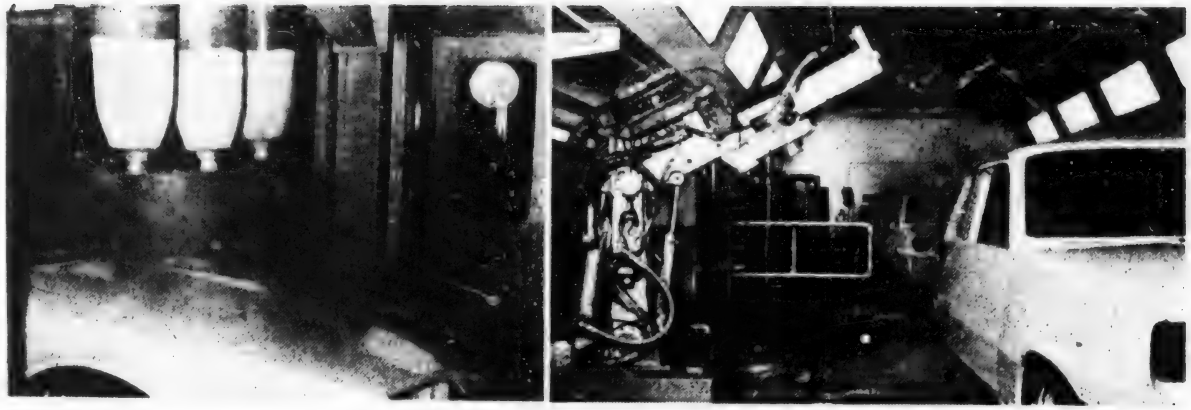
[Photos follow]



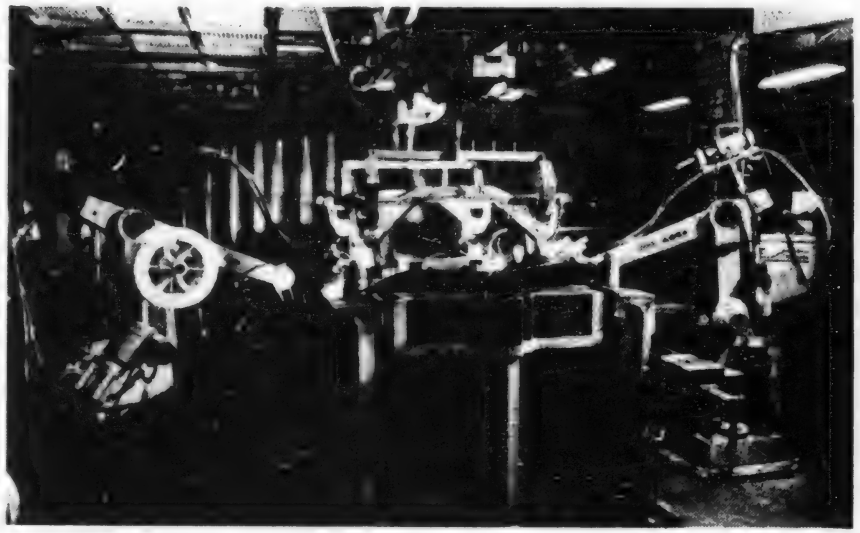
[Left] An arduous environment? The robot takes over from the human being. At Charleville, a robot does the "stripping" of Citroen engine-block castings.



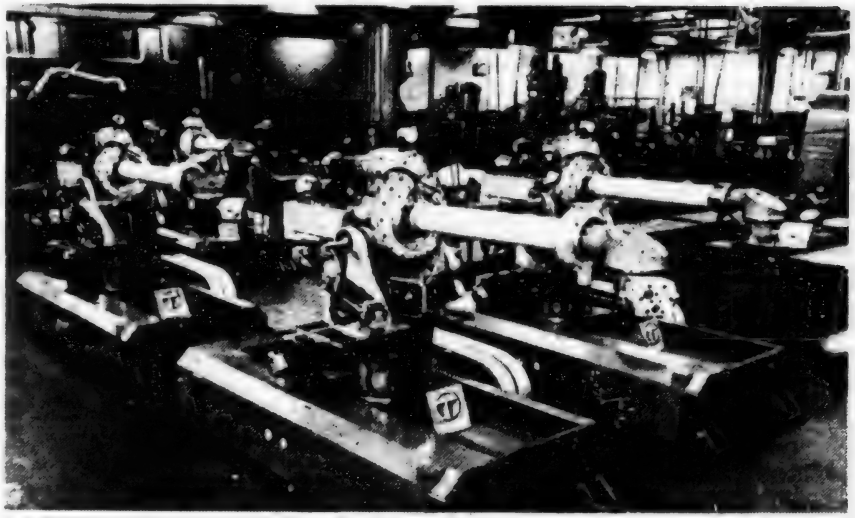
[Right] The multipoints: Economical but doomed. At Poissy, a multipoint welder for the side panels of the Samba.



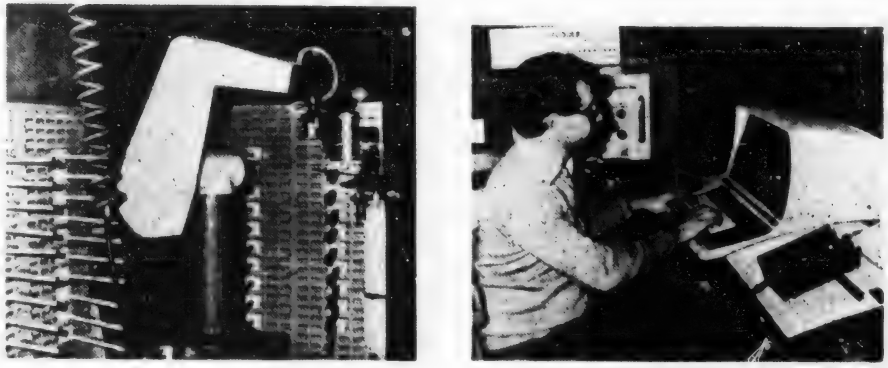
[Top] The robot to the aid of man for hazardous work: These "mini-cups" [left] at Citroen's Aulnay plant are a robot painter, as is the "elephant trunk" [right] installed at Flins.



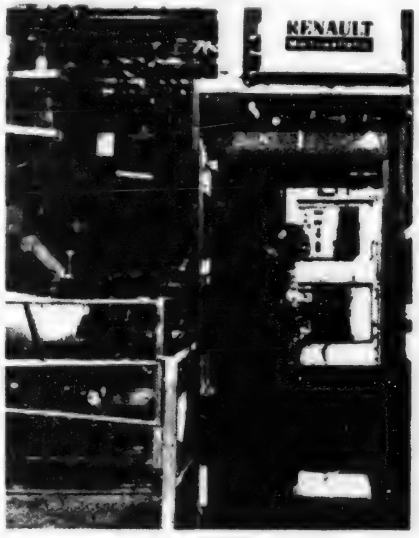
[Above] Citroen: Two "run-of-the-mill" Swedish robots, transformed by Citroen into world "firsts." They make continuous arc welds.



[Above] Talbot's "Made in Poissy" robot, Barnabe. Designed and built in Poissy, these robot welders are being tried out by Peugeot S.A.

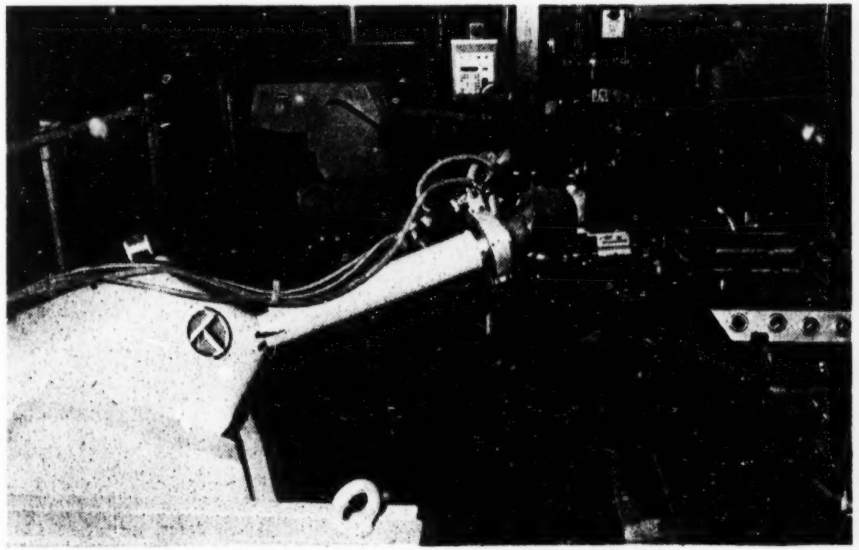


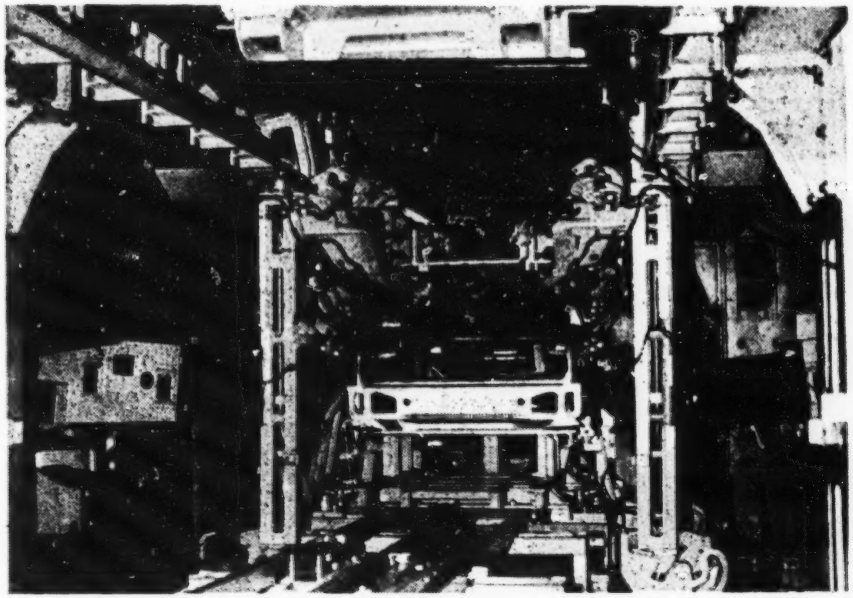
[Above] Citroen in the vanguard: This little Unimation robot [left] picks up a windshield, puts an adhesive glazing to it and returns it to a container. It is programed directly from a display console [right].



A salute to electronics! This robot represents the creation of a job in electronics and data processing.

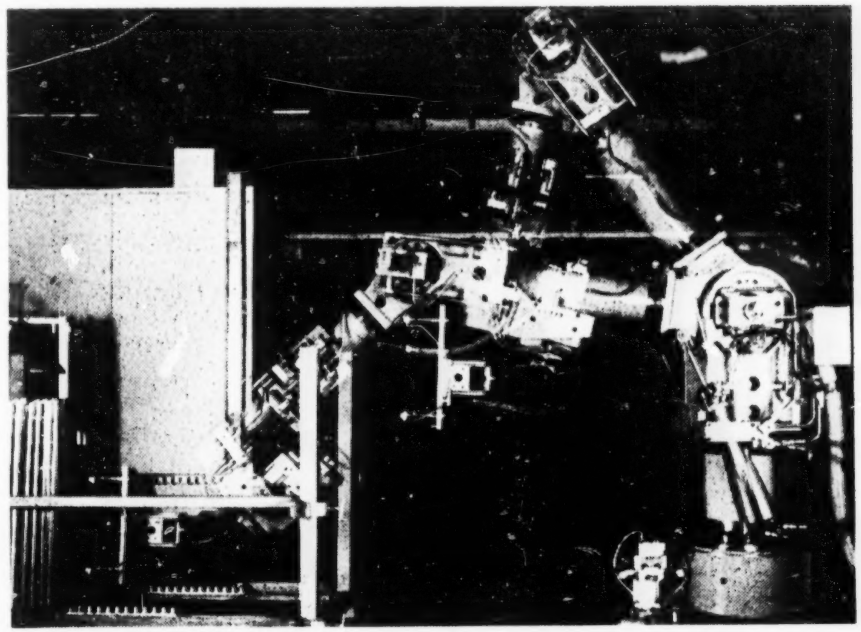
[Right] Barnabe: Easy maintenance and independence. A Talbot challenge to robotics experts that will benefit Peugeot S.A.

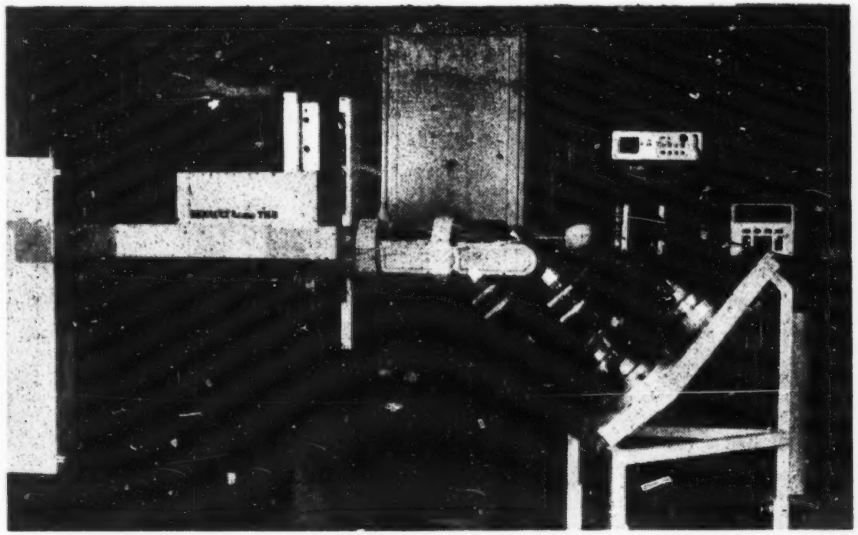




[Left] At Vigo, Citroen has adopted a Renault gantry-type robot painter for its Visa.

[Right] Smart transfer robots: A Renault 8-kg, electrically-powered robot keeps assembly lines supplied with parts.





[Left] Reliable transfer robots: This Renault 80-kg, hydraulically-powered robot can arrange parts in containers.

At Renault, the robot has acquired vision and the sense of touch. This electronic robot will be going to Cleon to unload crankshaft blanks.

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